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THE WEAR CHARACTERISTICS OF AISI310 GRADE STAINLESS STEEL MATERIAL BY CARBURIZING AND CARBONITRIDING PROCESS

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ABSTRACT

The wear conduct of AISI310 grade austenitic stainless steel is to be examined under a dry sliding contact at consistent load. It was found that carburising process will be successful in enhancing the wear conduct of stainless steel material, advancing the property of pliability. In carburising process maintenance at a constant temperature of 920^0C in difference timing samples as named CB1, CB2, CB3 and similarly carbonitriding samples were treated to temperature of 810^0C named as CN1, CN2 and CN3 at constant. Untreated stainless steel was utilized as a kind of perspective material and experienced wear test for comparison with different carburising samples. Small scale hardness estimations uncovered a critical increment in hardness after treatment. Wear tests are to be carried out by pin on disc testing machine. An untreated sample is used for comparison the results against the treated samples. The layers were portrayed by optical magnifying lens and scanning electron magnifying lens investigation.

KEYWORDS: Carburising, Metallographic Test & Wear Resistance

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Original Article

INTRODUCTION

Stainless steel with excellent corrosion resistance was widely used for surgical and medical instruments. But due to its low hardness and poor wear resistance, the life of the material is limited. Hence it limits their applications in manufacture of mechanical parts for engineering equipment and machines, where both corrosion resistance and wear enhancing the wear resistance of austenitic Stainless steel without deteriorating the corrosion resistance. Carburising and carbonitriding process improves the hardness of stainless steel material. AISI 310 grade austenitic stainless steel is remarkable for its best equality of carbon, chromium, nickel, phosphorus, silicon and manganese for utilization protection.

Table 1: **Composition of AISI 310 Grade Stainless Steel Material**

Composition of AISI 310 Grade Stainless Steel in %	C	Mn	Si	P	S	Ni	Cr
	0.25	2	1.5	0.04	0.03	19	24

SPECIMEN PREPARATION

Austenitic stainless steel AISI 310 specimenin cylindrical rod with dimensions of 8 mm diameter and 30mm length were selected. The Untreated specimen was subjected to wear tests with the help of pin on disc machine to determine the wear behaviour of the material. The samples were mechanically polished using abrasive paper from course to fine grade following standard polishing procedures. The samples were finally cleaned ultrasonically. Three samples were subjected to carburising and remains three samples were subjected to the carbonitriding process with the help of muffle furnace. The specimens were carburised at different times at constant temperature 9200C intervals like 2hr, 4hr. & 6hr. Similarly specimens were carbonitrided to different times at constant temperature 810^0C interval like 2hr, 4hr. &6hr. The untreated specimen and treated samples wear behaviour were compared and finally Rockwell hardness test is performed on specimens to find hardness of the individual specimen.

The following are experimental Parameters that were considered while doing wear tests. Load: 5kg (constant), Speed: 1000rpm (constant), Time: 3 mins (constant)**.** From the pin on disc the wear loss found to be in untreated sample was 0.46 grams, CB1 weight loss was found to be 0.37 grams, the CB2 weight loss was found to be 0.10 grams, CB3 weight loss was found to be 0.06 grams. Similarly, weight loss in CN1, CN2 and CN3 was found to be 0.48 grams, 0.19grams and 0.06 grams respectively.

HARDNESS TESTS

The hardness profile of the carburizing and carbonitriding AISI 310 stainless steel material was investigated using a Rockwell hardness tester. The hardness tests were performed under an indentation load of 150 grams for 15 seconds. The following readings were obtained. For the untreated AISI 310 Grade stainless steel, the hardness was found to be 84 HRC (Rockwell hardness “C” Scale). The hardness for carburising specimens CB1, CB2, CB3 was 88, 91, 94 HRC (Rockwell hardness “C” Scale). The hardness for carbonitriding specimens CB1, CB2, CB3 was 89, 93, 97 HRC (Rockwell hardness “C” Scale).

OPTICAL MICROSCOPE TESTS

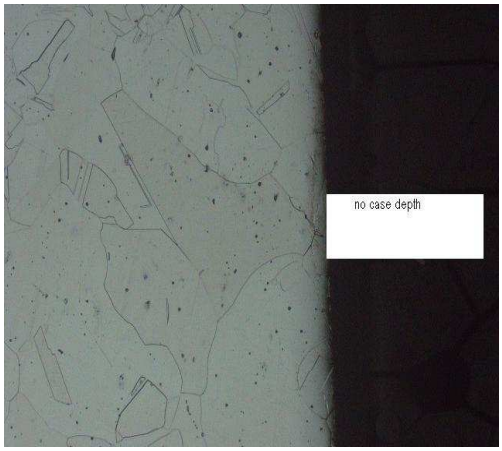

Figure 1: Case Depth for Untreated Specimen

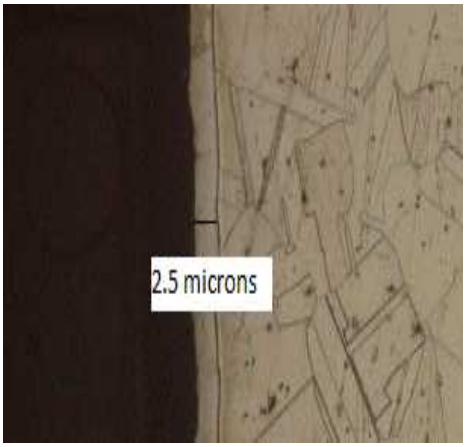

Figure 2: Case Depth for CB1 Specimen

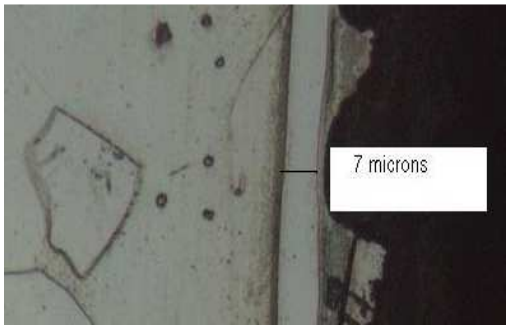

Figure 3: Case Depth forCB2 Specimen

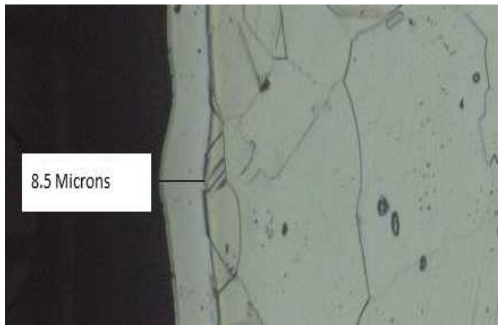

Figure 4: Case Depth for CB3 Specimen

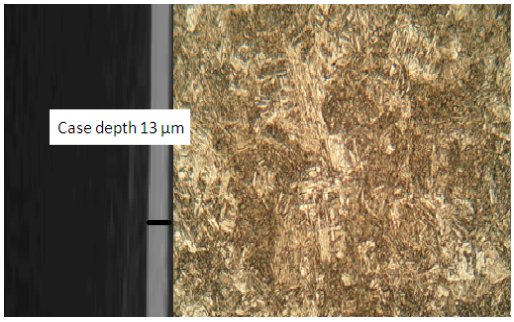

Figure 5: Case Depth for CN1 Specimen

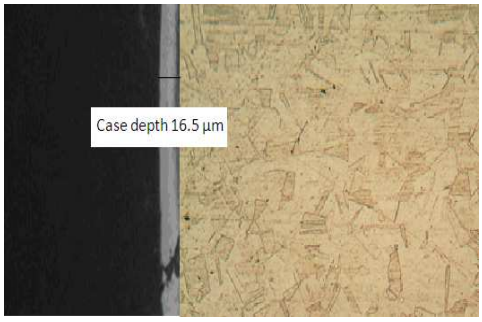

Figure 6: Case Depth for CN2 Specimen

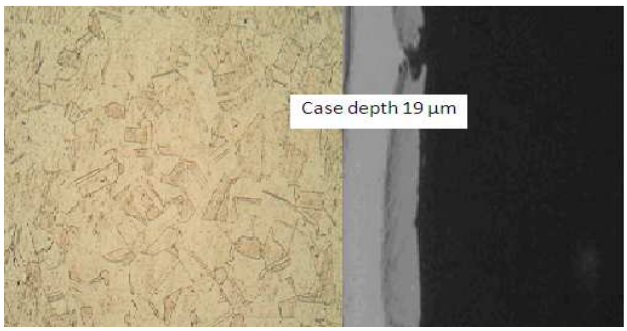

Figure 7: Case Depth for CN3 Specimen

From the figure 1, 2, 3, 4, 5, 6 & 7 it is seen that, as the time of carburizing and carbonitriding increases, case depth also increases. In an untreated specimen, no case depth was found. Whereas in treated specimens, the case depth is increased from 2.5, 7 and 8.5 microns in carburizing1, carburising 2, and carburising 3 specimens respectively. Similarly in carbonitriding process case depth increased from 13, 16.5 and 19 microns. The results are compared with untreated specimen and it was found that treated sample have shown have good case depth and better wear resistance against loads.

SCANNING ELECTRON MICROSCOPE RESULTS

Surface morphology and micro structural analysis of AISI310 Grade Austentic stainless steel were notified before and after surface treatment was carried out under Scanning Electron Microscopy (SEM) operated at an acceleration voltage of 15 kV. Scanning electron makes use of the focused beam of the high-energy electrons to generate a variety of signals at the surface of solid specimens. The analysis of the samples was done at 500x.

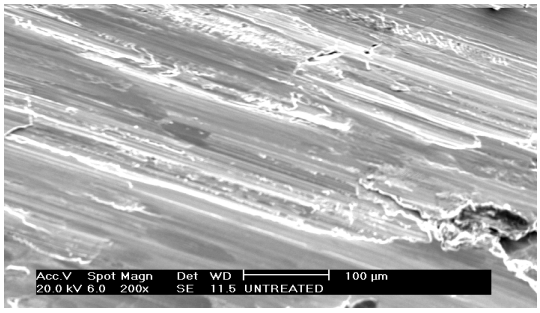

Figure 8: SEM Image of Untreated Specimen

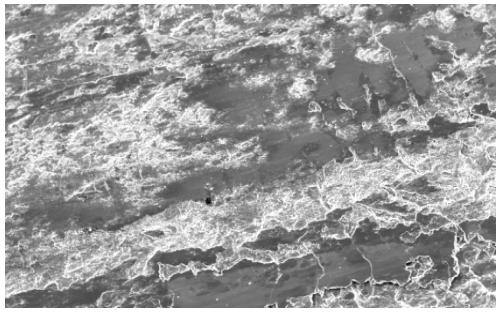

Figure 9: SEM Image of CB1 Specimen

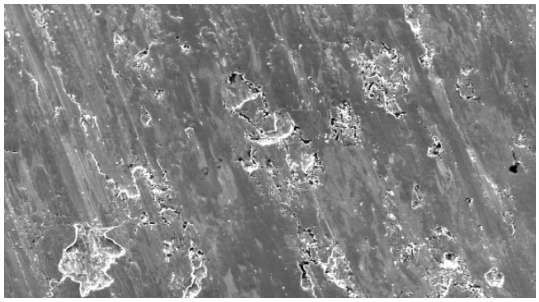

Figure 10: SEM Image of CB 2 Specimen

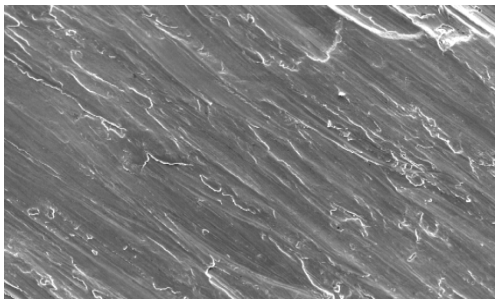

Figure 11: SEM Image of CB 3 Specimen

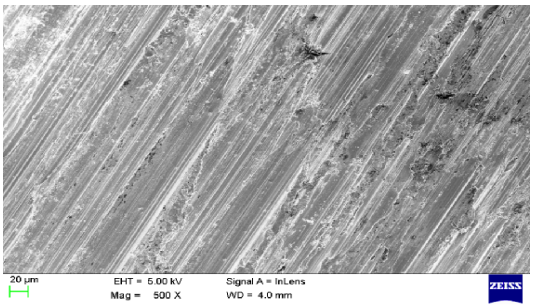

Figure 12: SEM Image of CN1 Specimen

Figure 13: SEM Image of CN 2 Specimen

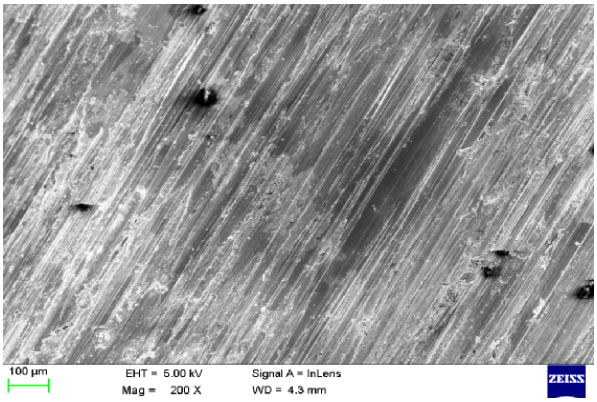

Figure 14: SEM Image of CN 3 Specimen

From the scanning electron microscope results, it was found that there was more peel of material from untreated specimen. As the time of heat treatment increases, wear decreases and wear loss decreases on the stainless steel material. There found to be less wear of material when it is subjected to load. Thereby wear resistance of the material increases, improving the property of ductility in stainless steel material and thereby increasing the hardness.

CONCLUSIONS

In this work, carbonitrided and carburising treated AISI310 grade stainless steels were performed and the wear behavior was studied. Here a comparison study was made of treated specimens with untreated samples. Carbonitriding and carburising are viable techniques to enhance the wear resistance of the stainless steel material. Several researchers investigated the effect of carbonitriding on mechanical and surface behaviour of carbon steels. Only little information is available on the wear behaviour of AISI 310 grade austenitic stainless steel material. The present study focused in the direction of investigating the effect of microstructure, hardness and wear resistance of AISI 310 stainless steel material. The major conclusions are as follows.

- In carburising process the case depth is found to be 2.5, 7, 8.5 Microns which are treated 2 hrs, 4hrs and 6 hrs respectively. Whereas in the Carbonitriding process the case depth was found to be from 13, 16.5 and 19 Microns which are treated at 2hours, 4 hours and 6 hours respectively.
- From the pin on disc- wear study we can find that CN 3 specimen has a very high wear resistance to time when compared to other treated samples. In general, the wear resistance of the carbonitrided specimens is found to be superior to the untreated specimens.
- The combined action of strong adhesion, abrasion and severe plastic deformation are the primary reasons for the continuous material loss in the untreated specimens during testing. Whereas the wear on the carburising specimen due to less case depth wear is reduced.
- In SEM analysis, carbonitrided specimens reveals very minute micro etch pits. They are visualized in the compound layer indicating the uneven distribution of carbon and nitride particles.
- The results of this work confirm that carbonitriding has effectively improved its wear resistance when compared to carburizing process. The wear resistance for the plasma nitriding is observed to high compared to others, because it has every even distribution of nitride on the surface.
- As the time for treatment increases the case depth, hardness increases. In general, the wear resistance of the carbonitrided specimens is found to be superior to the untreated specimens.

REFERENCES

1. *Jun Wang, Zhen Li, Danqi Wang, Shaoyu Qiu, Frank Erns (2017), Thermal stability of low-temperature-carburized austenitic stainless steel, Acta Materialia, Volume 128, Page No 235-240.*
2. *Yawei Peng, Chaoming Chen, Xuanyi Li, Jianming Gong, Yong Jiang, Zhe Liu (2017), Effect of low-temperature surface carburization on stress corrosion cracking of AISI 304 austenitic stainless steel, Surface and Coatings Technology, volume 328, Page No 420-427.*
3. *G. Maistro, C. Oikonomou, L. Rogström, L. Nyborg, (2017), Understanding the microstructure-properties relationship of low-temperature carburized austenitic stainless steels through EBSD analysis, Surface and Coatings Technology, Volume 322, Page No 141-151*
4. *Yawei Peng, Jianming Gong, Yong Jiang, Minghui Fu, Dongsong Rong (2017), The effect of plastic pre-strain on low-temperature surface carburization of AISI 304 austenitic stainless steel, Surface and Coatings Technology, Volume 304, Page No 16-22*

5. *Matthieu Rivollier, Jean-Louis Courouau, Michel Tabarant, Cécile Blanc, Marie-Laurence Giorgi (2017), Oxidation of 316L(N) stainless steel in liquid sodium at 650 °C, Journal of Nuclear Materials, Volume 500, Pages 337-348.*

6. *Thirumalvalavan, S., Senthil, R., & Gnanavelbabu, A. (2013). Effect of Heat Treatment on Tensile Strength, Hardness and Microstructure of AZ61A Magnesium Alloy. Science and Engineering (IJMMSE), 3(4), 39-48.*

7. *Zina Dhib, Noamen Guermazi, Ahmed Ktari, Monique Gasperini, Nader Haddar (2017), Mechanical bonding properties and interfacial morphologies of austenitic stainless steel clad plates, Materials Science and Engineering: A, Volume 696, Pages 374-386*

8. *A. Dalmau, C. Richard, A. Igual – Muñoz (2018), Degradation mechanisms in martensitic stainless steels: Wear, corrosion and tribocorrosion appraisa, Tribology International, Volume 121, Pages 167-179*

9. *Yang Yang, M. F. Yan, S. D. Zhang, J. H. Guo, S. S. Jiang, D. Y. Li (2018), Diffusion behavior of carbon and its hardening effect on plasma carburized M50NiL steel: Influences of treatment temperature and duration, Surface and Coatings Technology, Volume 333, Pages 96-103.*

10. *André Paulo Tschiptschin, Arthur Seij Nishikawa, Luis Bernardo Varela (2017), Thermal stability of expanded austenite formed on a DC plasma nitrided 316L austenitic stainless steel, Thin Solid Films, Volume 644, Pages 156-165.*

11. *M. M. A. Bepari (2017), Carburizing: A Method of Case Hardening of Steel, Comprehensive Materials Finishing, Pages 71–106, Volume 2.*